Structures and Properties of the Refractory Silicides Ti_5Si_3 and $TiSi_2$ and related Ti-Si-(Al) eutectic alloys

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The refractory titanium silicides Ti_5Si_3 and $TiSi_2$ with complex hexagonal $D8_8$ and orthorhombic C54 lattice structures exhibit some pronounced physical and mechanical properties, such as high lattice energies and melting temperatures; high hardness, elastic stiffness and flow stresses; low densities and excellent creep and oxidation resistance. The complex lattice structures and high binding energies of these compounds cause a lack in ductility due to sessile superdislocations. In order to increase the ductility of silicide containing alloys the binary and ternary Ti-Si-(Al) constitution is considered. Alpha titanium forms with the Ti_5Si_3 compound an eutectic system with large volume fractions Ti_5Si_2 of about 30 vol.% embeded in the hexagonal α-Ti(Si) solid solution. For the development of high temperature oxidation resistant Ti-Si-(Al) based alloys two different processing routes have been considered: One is directional solidification in order to achieve a fibre reinforcement of α-Ti matrices due to the presence of high strenght and elastically stiff discontinuous Ti_5Si_3 fibres which are aligned parallel to the road axes. The other route is to produce a fine-grained eutectic or hypoeutectic alloys with refined microstructure consisting of α-Ti(Al) solid solution with a fine dispersion of Ti_5Si_3 particles of several microns in size. These materials show improve ductility and fracture toughness.
The paper presents basic physical and mechanical properties of the high melting point silicides Ti_5Si_3 and $TiSi_2$ and of eutectic Ti-Si-Al alloy under consideration of their excellent high temperature properties.